I venture to think, therefore, that the proof is fairly complete that the luminosity of a candle or gas flame proceeds from incandescent matter in a state of extremely fine division, because—

(*A*) Light can be reflected from it in the same way as from very fine particles of lac, sulphur, &c.

(*B*) The reflection begins with the violet rays when the precipitate first forms, and extends to the red as it becomes denser in the upper smoky part of the flame, the spectrum undergoing a similar change to that of the acidulated hyposulphite solution.

(*C*) There is no break in the phenomena from the commencement of incandescence to the cooling smoke and even the cold soot itself. The reflection is visibly produced by any rays, whether of the sun or from a lamp, that are more intense than those of the incandescent body; and I imagine that light that is less intense is still reflected, though it cannot be discerned.

(*D*) The spectrum of light transmitted through a flame is complementary to that reflected from it, as is also the case with a solution containing fine particles.

(*E*) The peculiar property of polarising all light reflected at right angles to the line of incidence which is considered the test of solid matter in extremely fine division is possessed by all flames giving what is known as the "solid" spectrum.

(*F*) Whenever a precipitate is actually formed by a reaction known to take place in either inner or outer flame, the resulting luminous flame has the optical properties described in this paper. Thus zinc, which produces these results only in the outer flame, gives evidence of the solidity of its oxide in the form of smoke. And with the mixture of copper sulphate and ammonium chloride it is not that part of the flame that looks most like smoke to the eye, but that which gives a "hard" continuous spectrum which is found capable of reflecting light.

I am still working on the lines indicated by these experiments, and though the foregoing is all I feel justified in publishing at present, it by no means contains all the suggestive results I have obtained in my endeavour to ascertain the cause of luminosity in gases and substances vaporised in the Bunsen flame. My time is very much occupied and my appliances limited: it may be long before I can complete my researches, so I have thought it well to make public my conclusions, so far as they go.

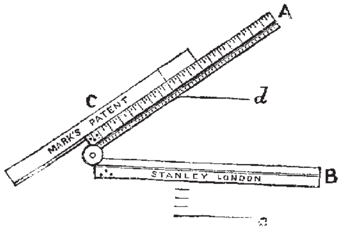
GEORGE J. BURCH

A LINE-DIVIDER

GALILEO'S proportional compasses are said to date from the year 1597. We infer that the instrument consisted of two arms, jointed, as in the accompanying figure, so that one arm could move freely about the joint. Each arm had a number of equal divisions (not necessarily of the same length on each arm), the zero point being at the joint. To divide a given length into five equal parts it is necessary to take an ordinary pair of compasses and measure the given length with these, then set the proportional compasses so that the fifth division on each arm may be at the given distance apart, then transfer with the ordinary compasses the distance between the unit divisions—this will be one-fifth of the given line. This seems to have been the manner of using the instrument employed by Galileo (cf. Marie, *Histoire des Sciences Mathématiques et Physiques*, tome iii. p. 108). Other modes of using will doubtless occur to most of our readers. The principle involved in this and similar instruments, and certainly in the one before us, is that of the proportionality of corresponding sides in similar triangles.

Our figure represents Miss Marks's patent line-divider for dividing any space into a number of equal parts. A B forms a hinged rule with a firm joint; each limb is ten inches in length (in the specimen we are describing), the limb B is bevelled, fronted with brass, and presents a straight edge, so that straight lines can be drawn along it. The limb A is also bevelled, and is divided on the bevelled edge and also on the top into eighty equal parts, so that we are enabled to divide a given length into any number of equal parts from two to eighty. A is fitted to slide in an undercut groove upon the plain rule C, which has a single line marked upon it, and is also provided with needle points on the under-side, to prevent it from slipping when placed in any position.

Suppose we take the case already considered. Slide C along A till the C line coincides with one of the lines on A, against which is the number 50. Place the corresponding line on the level of A on one end of the line to be divided, then open out or close up the rule till the bevel of B passes through the other end of the line. Now press the points on the underside of C firmly into the paper, and slide A up till the number 4 on the line of reference is coincident with the line on C, and mark the point where the bevel of B meets the given line to be divided. Continue to move A up one division at a time till the whole line is divided. If we require lines to be drawn through the several points of division in a given constant direction, it is obvious that we must fix the instrument so that the bevel of B shall be initially in the given direction.



We have said enough to show how the divider is used, and it remains only to state that it appears to be a very handy instrument for architects, engineers, and practical drawing. Stanley, of Great Turnstile, Holborn, is the maker.

UNIVERSAL TIME AND THE RAILWAYS

ONE of the reasons why the Prime Meridian Conference met at Washington was that the United States possesses the greatest longitudinal extension of any country traversed by railway and telegraph lines, and it is quite in keeping with the spirit of American institutions that some of the most important measures necessary to carry out the resolutions of the Conference were taken by the railway men before the scientific men had begun their sittings. The action of the railway companies began as far back as 1883. It was a regular rebellion against the inconvenience of having more than half a hundred standards of railway time from east to west of the continent. At the Conference itself, Mr. W. F. Allen, one of the United States delegates, who has from the first taken the greatest interest in this special branch of the subject, brought the matter prominently before the Congress, stating what had been done. Since the Conference met, the suggestions primarily due to the railway authorities have been accepted by the Army Signal Corps and other public bodies, and from the east of Canada to the Pacific the Continent is now divided into five sections, each with its time standard, differing by one hour from those to the east and west. Thus we have Intercolonial time, Eastern time, Central time, Mountain time, and Pacific time, representing differences of one hour or 15° of longitude. We append a map, and a paper by Mr. Allen, which we have received from an esteemed correspondent, which will show at once the history of this movement and what has come of it.

I. On November 18, 1883, the principal railway lines of the United States and Canada adopted a new method of computing and recording time, for the purpose of securing *a uniform time standard* which should simplify the business of transportation and add to the convenience of travellers. It is almost wholly for purposes of travel and transportation that the majority of people have need of accurate time, and everywhere, except in very large cities, business has always been regulated by railroad time.

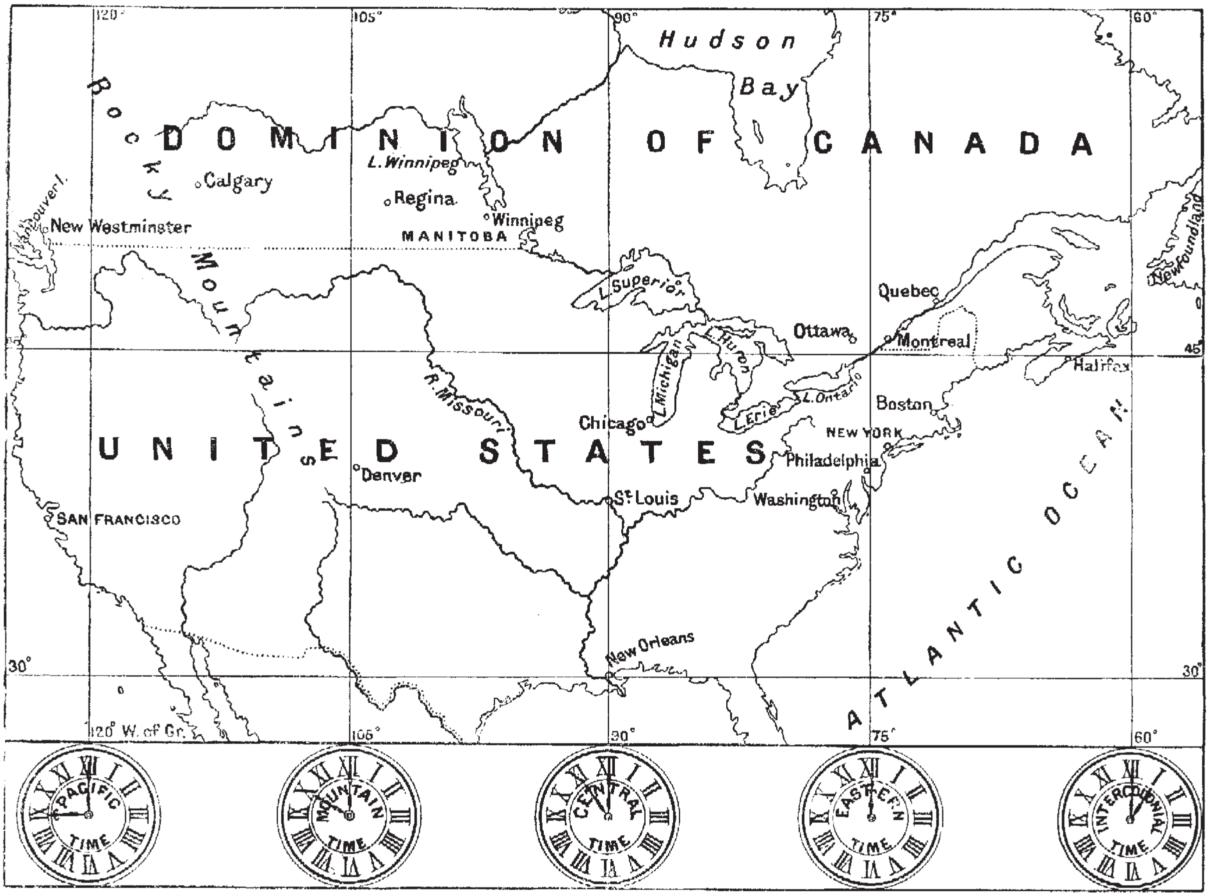
II. The defects of *the old system* of time standards were mainly as follows:—

(1) There were formerly more than fifty standards of railway time in the United States. Now there are but four.

(2) The old standards differed from each other, where they intersected, by all sorts of variations, errors, and odd minutes. Now the differences between the standards are an exact hour, and the minutes and seconds are the same in all four divisions.

(3) Formerly there were almost innumerable places at which standards changed. Now the points of change are few in number, and always at prominent points of railway departure.

(4) Formerly almost every railway centre had two or three standards of time. Chicago used three; Kansas City had five; and St. Louis, where fourteen roads centre, used six different standards.



Stanford's Geog. Estab.

III. In the plan which has now been adopted it was proposed:—

(1) That the same standard should govern as many railroads as possible.

(2) That the standards should not extend over so large an area of territory as to cause standard time to differ at any point by more than about thirty minutes from local time (mean solar time).

(3) That each standard should vary from the adjacent standards by the most readily-calculated difference, that of an even hour.

(4) That changes from one standard to another should be made at well known points of departure.

(5) That these changes should be made at the termini of roads where changes naturally occur, except on the transcontinental lines, and in a few other unavoidable cases, where they should be made at the ends of divisions.

(6) That the 75th meridian west from Greenwich being almost precisely the central meridian for the system of roads using standards based upon the time of eastern cities, and the 90th meridian being equally central for the roads running by the time of western cities, the time of those meridians should be adopted for the territory which includes nearly 90 per cent. of our whole railway system. The hour meridians east and west of those named (the 60th on the east, and the 105th and 120th on the west) were found to be equally well adapted as central meridians for the roads in the section of country adjacent thereto.

IV. The problem in this country presented a feature nowhere else encountered. Standard time was introduced throughout the island of Great Britain as long ago as the year 1848. When the railways demanded uniform time, and Greenwich time was adopted. France also has a uniform standard. But the continent of North America covers too many degrees of longitude to permit of the use of any one meridian as a single hour standard for all points between the two oceans. Under such a system there would be points where local time would differ from standard time by about two hours.

V. *The new system* divides the United States into four sections. At all places in the same section time is the same. The first section, which is governed by the time of the 75th meridian west from Greenwich, embraces all the territory between the Atlantic coast and Detroit, Pittsburg, Wheeling, Parkersburg, Huntington, Bristol, Augusta, and Charlestown, as indicated on the accompanying map (see next page). This is called *Eastern Time*. At 12.0 mid-day on the 75th meridian every clock and time-ball, from Calais to Pittsburg and from Quebec to Charlestown, indicates the hour of noon.

The second section is governed by the time of the 90th meridian, called *Central Time*. It includes all the territory from the western limits of the eastern time (that is, from Detroit, Pittsburg, Augusta, &c.) to Bismark, North Platt, Dodge City, &c. Time in this section is one hour slower than eastern time.

The third section extends from the last-named places westward to Heron (Montana), Ogden (Utah), the Needles (Arizona), &c. Time in this section is that of the 105th meridian (one hour slower than central time), and is denominated *Mountain Time*.

VI. At 12.0 noon in New York City the time at Chicago is 11 a.m., at Denver 10.0 a.m., and at Portland (Oregon) 9.0 a.m. By the old system at 12.0 noon in New York it was 11.05 in Chicago, 9.56 in Denver, and 8.46 in Portland.

VII. The adoption of a uniform standard of time by the railway lines has led to the *abandonment of local time* in nearly all the cities of the United States. The time of the 75th meridian was selected as the standard for the district of Columbia by Act of Congress, approved March 13, 1884.

It is encouraging to learn that, as was to have been expected, local time throughout the United States, as opposed to railway time, has already been abolished, and it is to be hoped, for the benefit of railway travellers on this side of the Atlantic, that the continent of Europe, from the extreme west of Spain to the Caspian, will soon be dealt with in the same manner.

NOTES

WE regret to state that Prof. Benjamin Silliman, of Yale College, died at Newhaven on the 13th inst , aged sixty-eight.

THE death is announced of Prof. Friedrich von Stein, at Prague, at the age of 67. He was appointed Professor of Zoology and Zootomy of the Prague University, an office which he occupied for thirty years.

THE death is also announced, at the age of fifty years, of Col. Roudaire, whose name is intimately associated with the project of a Saharan Inland Sea. Although strongly supported by M. de Lesseps, the scheme was opposed by the great number of competent scientific authorities. With the death of Col. Roudaire the scheme will probably fall to the ground.

THE Vice-Chancellor of Cambridge has appointed Mr. George John Romanes, M.A., F.R.S., to the office of Sir Robert Rede's lecturer for the ensuing year.

THE Royal Academy of Turin announces the foundation of a prize of the value of 12,000 francs for the most useful and striking discovery in anatomy, physiology, pathology, the exact sciences, history, geography, or statistics. The period within which the work must be done or the discovery made is from 1883 to December 31, 1886. Members of the Royal Academy or the Academy of Science in Turin are ineligible for the prize, the judges for which will be the Academy of Sciences of Turin.

THE Academy of Sciences, Berlin, announces the following subject for a prize of 2000 Marks, which, if sufficient merit be shown, will be awarded on the Leibnitz Anniversary in 1887:—"A determination of the nature of the primary assimilation-products of carbon-dioxide in plants; to be based upon suitable experiments and chemical investigations into the process in plants, when exposed to the influences of light; as well as upon direct histological demonstrations of the form it assumes in the tissues of the plant. The first form assumed by the assimilation-product is to be distinguished from the succeeding ones which the substance passes through in the metabolism of the cell. The chemical formulæ are also to be given. It will be considered an approximation to the solution of the question, if, by going over the work that has been done already on this subject, it shall be shown by an accurate series of observations and experiments that the present theories concerning the process of assimilation in plants and the primary organic product of this process, are susceptible of a wider extension, or that they require to be limited by important qualifications." Essays may be written in German, Latin, French, English, or Italian, and must be forwarded before January 1, 1887.

FROM subsequent information with regard to the accident to Dr. Divers, Principal of the Imperial College of Engineering, Tokio, it appears that he had taken in his hand a bottle supposed to contain perchloride of phosphorus, but, finding the stopper fast, was heating the neck to release it, when it burst, the bottle disappearing as dust, and the contents as gas. Dr. Divers was nearly suffocated by the fumes, and one eye was injured. When the last mail left, it was not in a state to be critically examined; but strong hopes are entertained that the sight will be restored. The accident is supposed to be due to the decomposition of the perchloride of phosphorus, which was old. Dr. Divers was at work on a paper on the theory of acids when the accident occurred.

THE undertaking to transport a whole Japanese village, with its shops, houses, and inhabitants, half round the globe to London, was a somewhat bold one for a private individual. But it has been performed with great thoroughness and success in the case of the Japanese village now on view at Knightsbridge. The houses are new and clean, which the tenements of Japanese villages always are not; the small temple or shrine is rather more cleanly and ornamental than is usual with these structures in real life; the wrestlers do not exhibit the physical characteristics which are so conspicuous, not to say disgusting, in the real Japanese wrestler; and their methods of refreshing themselves between the bouts are more in accordance with European tastes. But, on the whole, home-loving English people have now an opportunity of seeing the Japanese at home, which they can never have without a journey to Japan itself. There is very little to note in the exhibition from a scientific point of view; the inhabitants are fair average specimens of Japanese artisans and shopkeepers, so that the ethnologist will have a good opportunity of comparing his notions gathered from Miss Bird and other writers of the Japanese people with the reality. He can, in a measure, study the racial characteristics of the Japanese *in situ*.

THE Spanish earthquakes have continued to manifest themselves at intervals during the past week in the same area as that in which they first appeared. In connection with this phenomenon, the following extract from the report of the meeting of